PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B01J 7/00	A1	(11) International Publication Number: WO 90/03218 (43) International Publication Date: 5 April 1990 (05.04.90)

(21) International Application Number: PCT/SE89/00458

(22) International Filing Date: 1 September 1989 (01.09.89)

(30) Priority data:
8803446-7 28 September 1988 (28.09.88) SE

(71) Applicant (*for all designated States except US*): AGA AB [SE/SE]; S-181 81 Lidingö (SE).

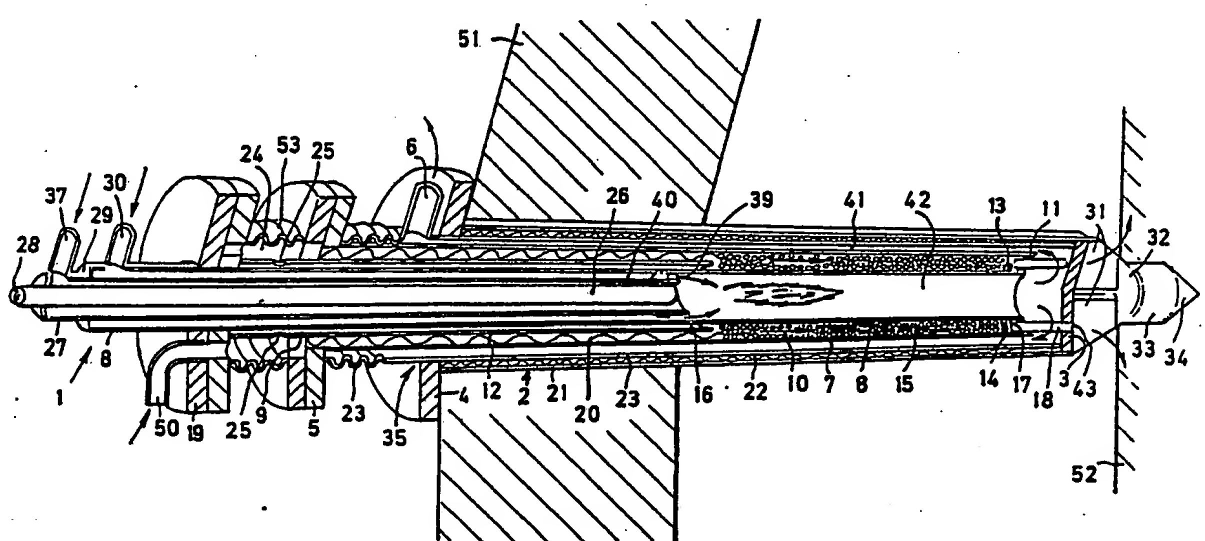
(72) Inventors; and
(75) Inventors/Applicants (*for US only*) : ANDERSSON, Rolf [SE/SE]; Skånegatan 109, S-116 37 Stockholm (SE). BACKMAN, Ragnar [SE/SE]; Sveaborgsvägen 42, S-723 55 Västerås (SE). WALL, Leif [SE/SE]; Flädergränd 13, S-183 73 Täby (SE).

(74) Agent: WIEDEMANN, Bernd; AGA AB, S-181 81 Lidingö (SE).

(81) Designated States: AT (European patent), BE (European patent), BR, CH (European patent), DE (European patent), DK, FI, FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.

Published
With international search report.

(54) Title: AN ENDOTHERMIC GAS GENERATOR



(57) Abstract

The invention relates to an endothermic gas generator (1) intended for heat treatment furnaces of the kind in which objects are heat treated under the influence of a process gas generated by catalytic reaction. The generator comprises an outer cylindrical casing (2) provided with an end wall (3) having process gas outlet openings (43). The generator further comprises an inner tube (8) which is located within the casing (2) in coaxial, spaced relationship therewith, and in which a burner (26) is inserted. A catalytic bed (15) is located outside the inner tube (8), between the forward end of the burner (26) and the end wall (3). The inventive generator is characterized in that the inner tube (8) forms in front of the burner (26) a burner gas channel (42) which communicates, between the end wall (3) and the catalytic bed (15), with a further burner gas channel (41) which is located radially outside the catalytic bed and extends along the whole length of the bed. The catalytic bed has the configuration of a cylindrical shell (15), which surrounds the inner tube (8).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Fasso
BG	Bulgaria
BJ	Benin
BR	Brazil
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CM	Cameroon
DE	Germany, Federal Republic of
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
HU	Hungary
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
RO	Romania
SD	Sudan
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

AN ENDOTHERMIC GAS GENERATOR

The present invention relates to an endothermic gas generator suitable for use with heat treatment furnaces of the kind in which metal objects are heat-treated under the influence of a process gas produced in the generator through catalytic reaction of a gas mixture. The gas generator includes an outer, hollow cylindrical casing, an inner tube which extends within the casing in coaxial spaced relationship therewith and which incorporates at least one burner pipe and at least one air supply pipe, a catalytic bed located inwardly of the outer casing, and outlet openings for the exit of gases generated in the catalytic bed.

Such gas generators are often used in heat treatment furnaces of the kind which are already equipped with simple radient tubes intended for heating purposes, wherein one or more such gas generators are placed in the location of said burners. The preamble of Claim 1 defines the construction of one such known gas generator which is intended to produce by catalytic reaction between natural gas and air a shielding gas for the heat treatment of metallic objects, e.g. for annealing and carbonitriding such objects. The known generator arrangement is also provided with furnace insulation which is effective in insulating the interior of the furnace. The purpose of this insulation is to prevent variations in furnace temperature from having a negative influence on the production of said shielding gas.

The heat treatment of metallic objects under the influence of a treatment or process gas can only be effected successfully when the process gas supplied to the treatment furnace at each and every point in time is

adapted optimally to the nature of the heat treatment carried out. When producing process or treatment gas in a known radient tube (gas generator), said gas consisting essentially of carbon monoxide, hydrogen and nitrogen, by catalytic reaction of a reactant gas, e.g. a mixture of natural gas or propane and air, the composition of the treatment gas is decided essentially by the composition of the reactant gas mixture and the temperature of the catalytic bed.

$$2CH_4 + (O_2 + 4N_2) \longrightarrow 2CO + 4H_2 + 4N_2$$

It is necessary to regulate or control the composition of the reactant gas mixture and also the bed temperature with great precision. This applies above all to the temperature of the catalytic bed, since the catalytic bed of known generators is subjected to wide variations in temperature.

Accordingly, one object of the present invention is to modify and to improve the gas generator defined in the preamble of Claim 1, so as to enable the temperature gradients in the catalytic bed to be controlled rigorously and therewith obtain an improved composite process gas for supply to the treatment furnace.

This object is achieved in accordance with the invention, by giving the catalytic bed the configuration of a cylindrical shell and by heating the interior and exterior of said bed with hot burner gases taken from a burner. To this end, a first inner pipe located in front of the burner and surrounded by the cylindrical, shell-like catalytic bed is arranged to function as a burner gas channel which communicates with a second burner gas channel located radially outside said bed.

Further characteristic features of the invention are set forth in the d pendent claims.

The inventive gas generator will now be described in more detail with reference to the accompanying drawing, the single figure of which is a schematic sectional view of the gas generator, taken through the longitudinal axis thereof.

The single figure of the drawing illustrates schematically an inventive gas generator 1 which comprises a cylindrical, hollow casing or jacket 2, a first circular end wall 3 and a second circular end wall 4. Provided on the outer surface of the first end wall 3, shown to the right in the drawing, is a number, e.g. four, of radially extending spacer members 31 which connect the outer casing 2 of the generator 1 with a disc-shaped element 32. Provided on the side of the element 32 remote from the spacer members 31 is a circular body 33, the free end 34 of which tapers to a point.

In use, the gas generator 1 is passed, with said pointed end first, through an opening in a first furnace wall 51 and is moved axially until the second end wall 4 comes into contact with the outer surface of said first furnace wall 51. The circular body located externally of the disc-shaped element will then project into an opening in a furnace wall 52 located opposite said first wall 51. The distance between the second end wall 4 of the generator 1 and the disc-shaped element 32 is equal essentially to the sum of the thickness of wall 51 and the internal width of the furnace.

The cylindrical outer casing or jacket 2 of the generator 1 comprises an outer tube 21 and an inner tube 23

which extends concentrically with the outer tube 21. The outer tube 21 is located betw en the end walls 3 and 4, whereas the right-hand side of the inner tube 23 (as seen in the drawing) is connected with the end wall 3 and extends through a central opening 35 in the second end wall 4 (shown to the left in the drawing) and is connected with a flange 5 or to a flange-shaped end wall spaced from the end wall 4. The inner tube 23 of the casing 2 is provided with an outlet 6 at a location close to the second end wall 4 and between said wall and the flange 5. The tube 23 is also corrugated in a region thereof located between the outlet 6 and the flange 5. Heat insulating material, e.g. mineral wool, is placed in the space 22 defined by the two tubes 21, 23 and the end walls 3, 4.

Extending concentrically with the cylindrical casing 2 and radially inwards thereof is an elongated chamber 10 of circular cross-section. The chamber 10 is defined by two mutually spaced and mutually concentrical tubular walls 7, 8, said walls also being concentrical with the outer casing 2. The outer wall surface of the tubular wall 7 of the chamber 10 is spaced from the inner tube 23 of the casing 2. An annular end wall 11 connects the tubular walls 7, 8 at the ends thereof located nearest the end wall 3. The end wall 3 is located at a relatively short distance from the annular end wall 11. The outer end of the outer cylindrical wall 7 of the chamber 10, i.e. the end opposite the annular end wall 11 is connected to and terminates in the flange-like wall 5. The inner cylindrical wall 8 is longer than the outer tubular wall 7 of the chamber 10 and extends through an opening 9 in the flange-like wall 5. The chamber 10 further includes a third tubular member 12, the outer end of which passes through the opening 9 in the flange-

like wall 5. The outer diameter of the tubular member 12 is equal to the diameter of th opening 9 and said member thus abuts the inner peripheral surface of said opening. The tubular member 12 extends into the chamber 10 and also beyond the end wall 4. The distance from the inner end of the member 12 to the plane of the end wall 4 corresponds to the thickness of the furnace wall 51. The tubular member 12 extends concentrically with the walls 7, 8 of the chamber 10. The internal diameter of the tubular member 12 is slightly larger than the outer diameter of the tubular wall 8. The space 20, which forms part of the chamber 10 and which is defined by the outer surface of the tubular member 12 and a corresponding length of the inner surface of the tubular wall 7 between the flange 5 and the inner end of the tubular member 12, is filled with an insulating material.

The tubular wall 8 has provided thereon an annular wall 13 which is spaced from the annular end wall 11 in a direction towards the second end wall 4. The inner peripheral surface of the annular wall 13 is spaced from the outer surface of the tube 7, such as to form an annular gap 14. The annular wall 13 may also connect the walls 7 and 8, wherewith openings provided in the wall 13 connect the two spaces or chambers 15, 17 separated by the wall 13. The chamber space 15 defined by the walls 7 and 8, the annular wall 13 and the end of the tubular member 12 is filled with a catalyst, normally a particulate catalyst. These catalyst particles have a size which prevents said particles from passing through the annular gap or openings in the wall 13, and also through the annular channel 16 formed by the mutually concentric tube 8 and tubular member 12. A tubular perforated wall or net structure may optionally be arranged between the walls 7 and 8, at the inner end of

the tubular member 12.

The space 17 defined by the walls 7, 8, the end wall 11 and the annular wall 13 communicates with the ambient surroundings of the gas generator 1 through a plurality of tubular conduits 18, which are disposed in a ring and which extend through the annular wall 11, the gap defined between the wall 11 and the wall 3, and also through the end wall 3. The tubular conduits 18 have outlet orifices 43 located in the end wall 3, these orifices 43 being directed towards the disc-shaped element 32.

Spaced from the flange-like wall 5, to the left of the figure, is a further flange-like wall 19 which has a central opening that surrounds the tube 8. Located between the flange-like walls 5 and 19 is a corrugated tube 53 whose diameter is substantially equal to the diameter of the wall 23. The tube 53 forms, together with the flange-like walls 5 and 19 and the tube 8, an annular chamber 24 which communicates with the annular channel 16, through openings 25 provided in the tube 8, and therewith also with the catalytic bed in the space 15. The chamber 24 also communicates with a source (not shown) of air and fuel, through a conduit 50 which extends through the flange-like wall 19. The fuel is normally natural gas, i.e. a mixture of predominantly methane together with other low molecular alkanes, although a mixture of alkanes of another composition than natural gas, or solely an alkane, e.g. propane, can be used.

The outer part of the tubular wall 8 also forms the outer casing wall of a burner 26. The tubular wall 8 extends beyond the end wall 19 and passes through a

central opening in said wall, said tubular wall 8 being sealingly embraced by said opening. Th burner 26 includes three mutually concentrical tubes 8, 27 and 28, of which the tube 8 is the outermost tube and the tube 28 the innermost tube. The left-hand end of the tube 8, as seen in the drawing, has arranged thereon an annular end wall 29 which sealingly embraces the innermost tube 27 of the burner 26. An inlet opening 30 for oxygen-containing gas is provided in the tubular wall 8 at a location between the end walls 19 and 29. An annular end wall 36 spaced from the end wall 29, to the left in the drawing, connects the end of the tube 28 with the peripheral surface of the tube 27. A fuel inlet 37 is provided in the innermost tube 27, between the tubular walls 29 and 36. The left-hand end of the tube 28 is connected to a circular end wall 38.

The tubes 27 and 28 extend into the cylindrical space defined by the tube 8. The inner, i.e. in the figure the left-hand end of these tubes 27, 28 is located approximately level with the inner end of the tubular member 12. Preferably, the inner end of the tubes 27, 28 will be located closer to the end wall 4 than the inner end of the tubular member 12. The tubular walls 27, 28 are held in their respective positions in the tubular wall 8 by spacer elements not shown. An annular collar 39 is spaced at a short distance from the inner end of the tube 27. An annular gap 40 is defined between the outer peripheral surface of the annular collar 39 and the tube 8. Provided in the inner end of the tube 28 is an ignition or firing device (not shown) which is connected to a control means by electrical conductors (not shown) extending through the end wall 38.

The gas g nerator 1 is also provided with a narrow-bore conduit through which small samples of the gas produced can be taken. The inner end of the conduit is located within the space 17, which communicates with the catalytic bed in the space 15, and extends from the space 17 along the tubular wall 7, to the external surroundings of the generator 1, through openings (not shown) provided in the walls 5 and 19. Furthermore, the catalytic bed has provided therein at least one temperature responsive body. The temperature responsive body is connected to electrical conductors located adjacent the inner surface of the tubular wall 7 and extending to the external surroundings of the generator, where said conductors are connected to control equipment.

The inner end of the burner 26 is formed by the inner ends of respective tubes 27 and 28. The space located forwardly of the burner 26, which is embraced by the tube 8, forms a burner gas channel 42 which is connected with a shell-like space 41 between the chamber 10 and the outer casing 2, via the intermediate space between the end wall 3 and the end wall 11. The space 41 is an extension of the burner gas channel 42. The outer casing 2 presents in the tube 23 the outlet 6 for burner gases.

In use, the gas generator 1 is placed in a treatment furnace and supplied with air or some other oxygen-containing gas, through the inlet 30 of the burner 26. The oxygen containing gas then flows into the annular space between the tubular wall 8 and the wall 27, and through the gap 40 defined between the peripheral surface of the collar 39, and the tubular wall 8. Turbulence is imparted to the flow of oxygen-containing gas on the downstream side of the collar 39, so that the gas will readily mix with natural gas flowing between the

tubes 27 and 28. The fuel is supplied to the burner 26 through the inlet 37, and is mixed with the oxygen-containing gas in front of the burner 26. The burner 26 is ignited by means of the ignition element mounted in the tube 28. The burner gases flow towards the end wall 3 and thereafter to the gap-like burner gas channel 41, and leave said channel 41 through the outlet 6, whereafter the gases are led away to the generator surroundings.

When the working temperature of the catalyst has reached a pre-determined value, e.g. 1100°C, a mixture of air and natural gas is supplied to the generator 1, through the inlet 50. This gas mixture flows into the space 24 and thereafter through the openings 25 and into the channel 16 defined between the tubular member 12 and the tubular wall 8. The gas flows from the channel 16 through the catalytic bed, where the desired process gas mixture is produced. The process gas flows from the catalytic bed through the gap 14 and into the space 17, and thereafter through the conduits 18 through the end wall 3. The process gases flow towards the disc-shaped element 32 and then propagates in the furnace space.

Because the catalytic bed is configured as a cylindrical shell which is heated on both the internal and external surfaces thereof by the burner gases exiting from the burner 26, an even temperature distribution is obtained in the catalytic bed. The amount of heat delivered by the burner is controlled with the aid of temperature sensors in the catalytic bed, such that the bed temperature will lie within a predetermined range. Gas samples may be taken from the space 17, for the purpose of monitoring the composition of the process gas and controlling the gas components delivered to the inlet 50.

Because the reactant-gas supply conduit 16 is embraced externally by an insulator and is cooled internally by cold combustion air supplied to the burner 26, the reactant gas contacting the catalytic bed will be cold. Consequently, the catalyst can be maintained at a higher temperature than would otherwise be the case if hot gas was able to reach the bed. Cooling of the reactant gas will also prevent the gas from decomposing before it reaches the catalyst.

CLAIMS

1. An endothermic gas generator (1) intended for heat treatment furnaces in which objects are heat treated under the influence of process gas generated by catalytic reaction, said generator including an outer cylindrical casing (2) having an end wall (3) provided with process gas outlets (43), an inner tube (8) which is arranged within the casing (2) in coaxial spaced relationship therewith and in which a burner (26) is inserted, and a catalytic bed (15) located externally of the inner tube (8) between the forward end of the burner (26) and said end wall (3), characterized in that the inner tube (8) forms in front of the burner (26) a burner gas channel (42) which communicates between said end wall (3) and the catalytic bed (15) with a second burner gas channel (41) which extends along the whole of the catalytic bed radially outside said bed.

2. A gas generator according to Claim 1, characterized in that the catalytic bed has the form of a cylindrical shell (15) which surrounds the inner tube (8).

3. A gas generator according to Claim 1 or 2, characterised in that an annular chamber (17) is arranged at a location adjacent the catalytic bed (15) and at a distance from the end wall (3), said chamber (17) communicating with said catalytic bed (15).

4. A gas generator according to Claim 3, characterized in that the annular chamber (17) communicates with the gas outlets (43) in said end wall (3) through conduits (18).

5. A gas generator according to Claim 3 or 4, characterized in that said generator is provided with a sampling conduit which connects the annular chamber (17) with the ambient surroundings of the generator (1).

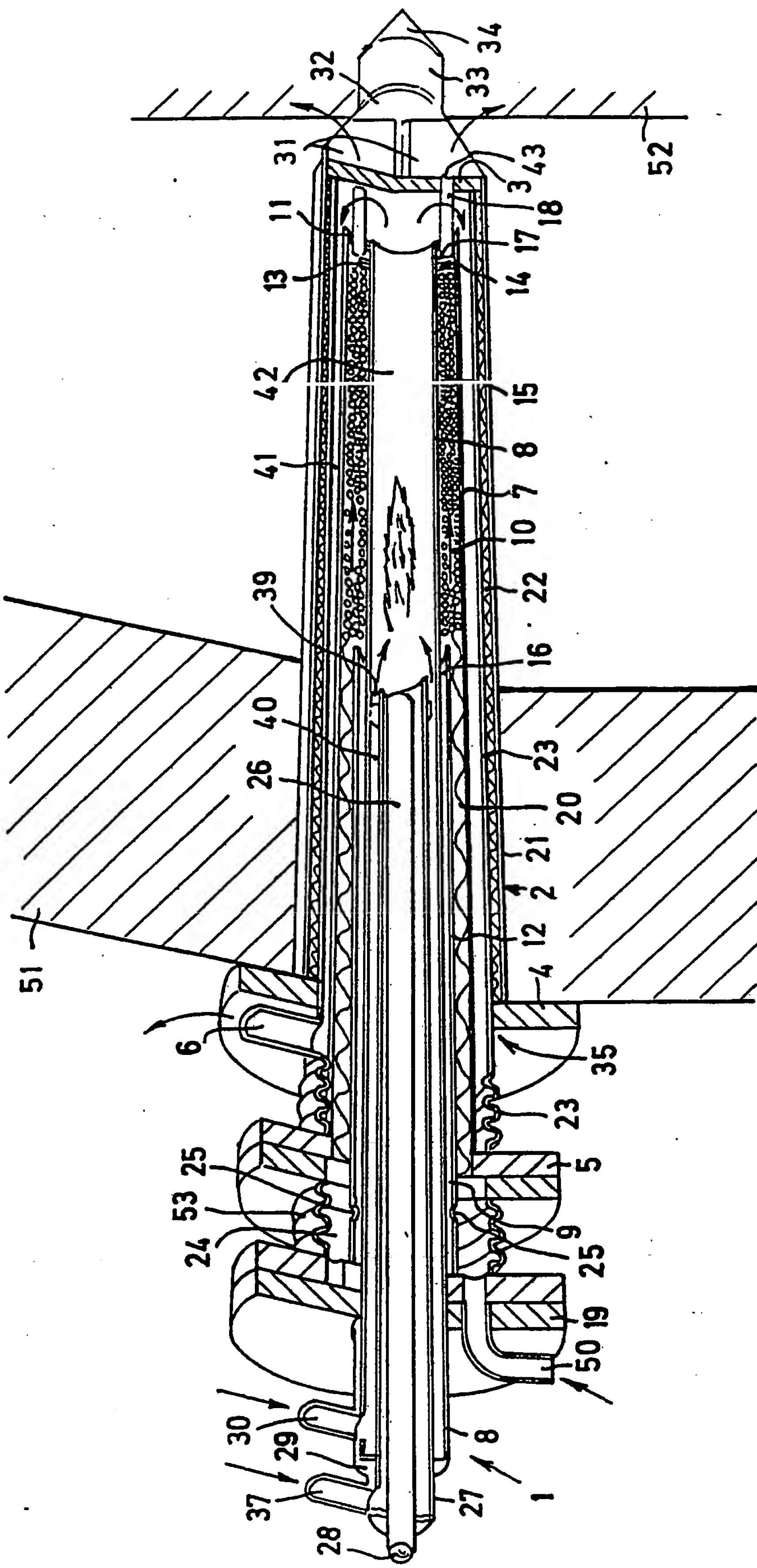
6. A gas generator according to one or more of Claims 1-5, characterized in that a temperature sensor is arranged in the catalytic bed (15).

7. A gas generator according to one or more of Claims 1-6, characterized in that the generator (1) includes a disc-shaped element (32) which is spaced from and located opposite to the gas outlet openings (18) and against which the process gas flows.

8. A gas generator according to one or more of Claims 1-7, characterized by a conduit (16) for supplying reactant gas to the catalytic bed (15), said supply conduit having a circular cross-section and extending coaxially with and externally of the burner (26).

9. A gas generator according to one or more of Claims 1-8, characterized in that the outer tubular casing (2) comprises two mutually concentric walls (21, 23) which define a chamber (22) therebetween; and in that an insulator is provided in said chamber.

10. A gas generator according to one or more of Claims 1-9, characterized in that the supply conduit (16) is embraced by an insulator and a conduit for cold oxygen-containing gas, said cold gas conduit consisting of two mutually concentric conduits (8) and (27).


34
32
33
52
31
43
3
18
11
17
13
14
42
15
41
8
7
10
22
39
16
40
23
26
20
21
2
12
51
4
6
35
23
5
25
53
9
24
25
19
50
30
29
8
37
1
27
28

INTERNATIONAL SEARCH REP RT

International Application No PCT/SE89/00458

I. CLASSIFICATION F SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 01 J 7/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 01 J; C 01 B
US Cl	23; 48; 422; 423

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	SE, B, 420 485 (S.Z VASILIEV ET AL) 12 October 1981 see page 10, line 36 – page 11, line 14; figure 4	1-10
A	US, A, 2 873 173 (M.J. NEUMEYER) 10 February 1959	1-10
A	EP, A2, 0 180 953 (LINDE AKTIENGESELLSCHAFT) 14 May 1986	1-10
A	DE, A1, 2 363 709 (BROWN, BOVERI & CIE AG) 10 July 1975	1-10

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1989-11-20	1989 -11- 24
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Britt-Marie Lundell